Pacific Island Network
Vital Signs Monitoring Plan

Appendix A: Kalaupapa National Historical Park Resource Overview

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Pacific Island Network (PACN)

Territory of Guam
War in the Pacific National Historical Park (WAPA)

Commonwealth of the Northern Mariana Islands
American Memorial Park, Saipan (AMME)

Territory of American Samoa
National Park of American Samoa (NPSA)

State of Hawaii
USS Arizona Memorial, Oahu (USAR)
Kalaupapa National Historical Park, Molokai (KALA)
Haleakala National Park, Maui (HALE)
Ala Kahakai National Historic Trail, Hawaii (ALKA)
Puukohola Heiau National Historic Site, Hawaii (PUHE)
Kaloko-Honokohau National Historical Park, Hawaii (KAHO)
Puuhonua o Honaunau National Historical Park, Hawaii (PUHO)
Hawaii Volcanoes National Park, Hawaii (HAVO)

http://science.nature.nps.gov/im/units/pacn/monitoring/plan/

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EXECUTIVE SUMMARY

Enabling Legislation

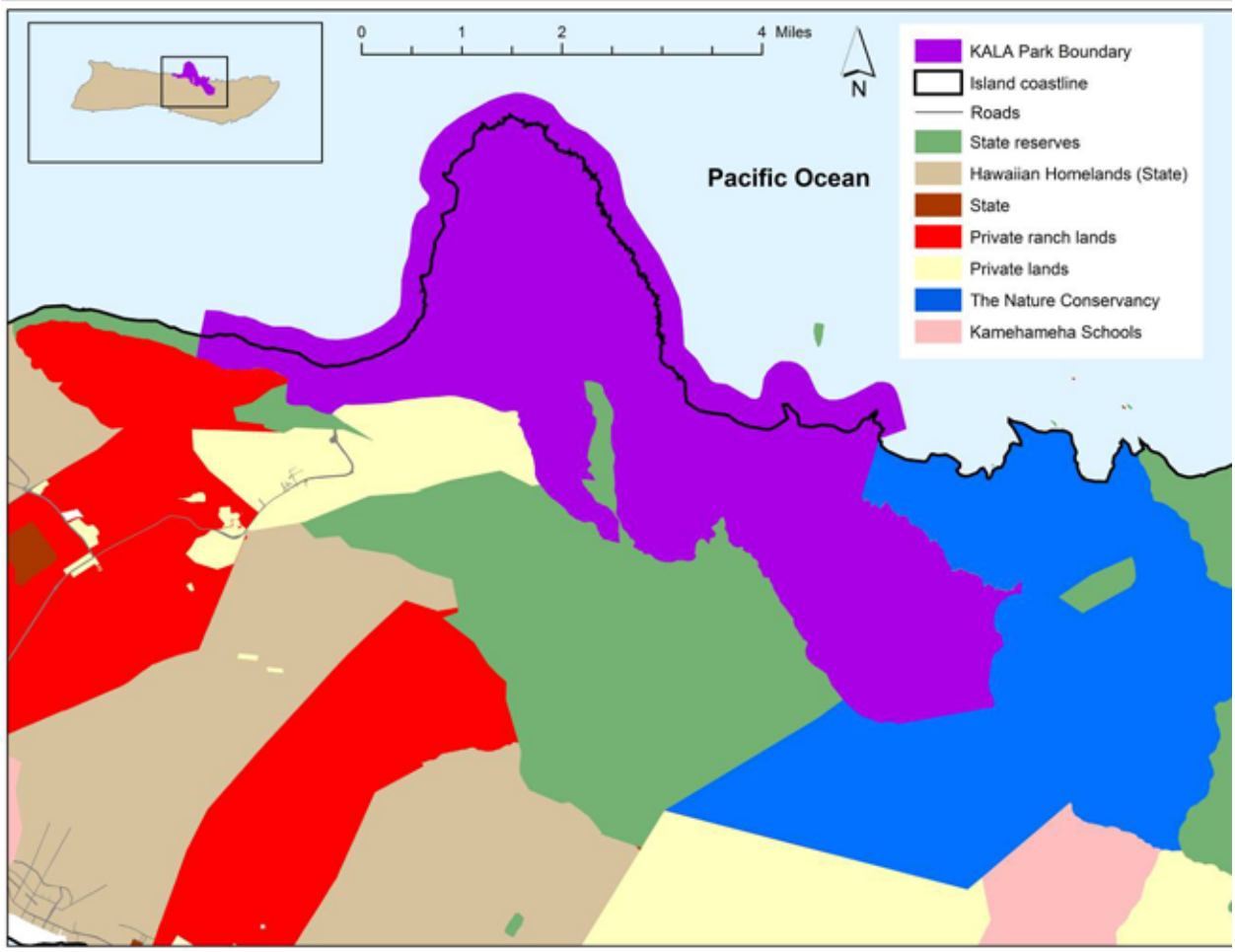
Kalaupapa National Historical Park (KALA) was created December 22, 1980 in order to provide for the preservation of the unique cultural, historic, educational, and scenic resources of Kalaupapa Peninsula. The park preserves and interprets the Kalaupapa settlement, community, and the current lifestyle of the patients. The park also maintains important historic structures, traditional Hawaiian sites, and natural features. Limited visitation by the general public is allowed. Preservation and interpretation of the settlement is to be managed and performed by patients and Native Hawaiians to the extent practical. The park contains the Kalaupapa Leprosy Settlement, which is listed on the National Register of Historic Places as a National Historic Landmark. A section of the park is included within the North Shore Cliffs National Natural Landmark. The Puu Alii plateau is a designated state Natural Area Reserve (NAR) and is also included within the authorized boundary of the park. The Molokai Lighthouse is listed separately on the National Register of Historic Places.

To find enabling legislation documents on-line follow the "Policy & Legislation" link from the Pacific Island Network website (www1.nature.nps.gov/im/units/pacn).

Geographic Setting

Located on the north shore of the island of Molokai, Kalaupapa National Historical Park is roughly 10,800 acres encompassing a wide variety of habitats from submerged marine resources to lowland coastal, mesic, and rainforest habitats including the State of Hawaii's Puu Alii Natural Area Reserve (NAR), a premier example of a native Hawaiian rainforest on Molokai. Visitation averages approximately 76,000 people per year (only guests of residents may stay overnight or leave the Kalaupapa settlement boundaries when accompanied by their sponsor). The community of Kalaupapa, on the leeward side of the Kalaupapa Peninsula, is still home to surviving Hansen's disease patients. Access to the park is by boat, air, or down a steep trail. The park's boundary extends for a quarter mile offshore and includes 2,000 acres of ocean, two small islets, and shorelines. Nearly all of the land within the authorized boundary remains in non-federal ownership, although it is managed by the National Park Service through several cooperative agreements. Surrounding land use includes conservation land and ranch land. Land owners include the Department of Hawaiian Home Lands, the State of Hawaii Departments of Health, Transportation, and Land and Natural Resources, The Nature Conservancy of Hawaii, and other private land owners, including R.W. Meyer Ltd. The U.S. Coast Guard owns and operates the Molokai Lighthouse. The Nature Conservancy of Hawaii manages Kamakou and Pelekunu Preserves; Moomomi Preserve is nearby (towards west Molokai), but not adjacent to Kalaupapa. On the peninsula, median annual rainfall ranges from less than 25 inches to 75 inches. The Puu Alii–Ohialele Plateau and Waikolu Valley are the wettest spots within the park and include upper-elevation rain forests. Waikolu Valley has a perennial freshwater stream and Waihanau and Waialeia

Valleys contain intermittent streams. Wainene, Anapuhi, Waiohookalo, Keawanui, Kailiili, and Pelekunu streams are associated with Pelekunu Preserve (Hawaii Cooperative Park Service Unit 1990) and Puu Alii NAR.



Significant Natural and Cultural Resources

The park encompasses the north shore cliffs, intervening valleys, a volcanic crater with a crater lake, rain forest, lava tubes, caves, offshore islets and surrounding marine waters out to a ¼ mile. Within the park, Kauhako Crater rises 402 feet above sea level, and has a crater lake that is over 800 feet deep. Nearly 30 federally-listed threatened and endangered species of plants and animals have been identified within the park. Introduced animals remain including axis deer (*Axis axis*), feral goats (*Capra hircus*), feral pigs (*Sus scrofa*), mongoose (*Herpestes auropunctatus*), rats (*Rattus* spp.), cats (*Felis catus*), and dogs (*Canis familaris)*. Kauhako Lake contains an unusual microbial fauna. A new species of copepod and a genetically isolated population of shrimp (probably *Palaeomon debilis*) were found in the lake in 1999. Lava tubes and caves on the peninsula contain endemic invertebrate species and incompletely inventoried flora and fauna. There are several streams which are at least partially within Kalaupapa. Most of Waihanau, Waialeia, and Waikolu are in the park (except for headwaters). For

Wainene, Anapuhi, Waiohookalo, Keawanui, Kailiili, and Pelekunu, headwater sections are within the park- although these may be seasonal or intermittent. All these streams are considered perennial by the state (though "perennial" may mean only permanent pools and not running to the sea all the time) and provide aquatic habitat. Perennial Waikolu Stream contains five native diadromous fish species, native snails, and shrimp. Surface water and groundwater withdrawn from Waikolu Stream and Valley is the source of most water for the western half of Molokai. Water diversion has been shown to have adverse impacts on native fauna. An anchialine pool exists within the park, and had historically been modified for use as a fishpond (although it is no longer kept up). Significant marine resources include the presence of endangered species (e.g. monk seal and humpback whale), threatened species (e.g. green sea turtle), and well preserved high wave energy coral reef communities, including marine intertidal and fish resources.

The park's most significant cultural resource are the Hansen's Disease patients, who continue to live in Kalaupapa. Their presence, knowledge, and background make this park unique in the National Park System. There are 400 homes, churches, monuments, and associated structures, which interpret the history of the settlements. Two of the most important structures are the two churches at the site of the original settlement in Kalawao. One of the churches was remodeled by the internationally recognized Belgian priest, Father Damien de Veuster. The historic information and objects collected by both patients and the Park Service provide knowledge and insight into the lives of the residents of Kalaupapa and help to tell the story of the settlements. Archaeological remains, including the stone ruins of ancient temple sites and terrace walls, provide clues to the history of the native Hawaiians who lived on the peninsula and in the valleys before the area became a Hansen's Disease settlement.

Resource Management Priorities

Resource management priorities include preservation of native ecosystems and the native species that inhabit them as well as control of non-native species. These tasks are performed through cooperative management with adjacent land owners and community groups as a major strategy for resource protection. Water diversion is a concern for the park resources. Cultural resource priorities include stabilization, preservation, protection, and interpretation of archeological sites while resident patients live on the peninsula.

NATURAL RESOURCES

Focal Ecosystems and Processes

- Plant communities
- Rare insect species
- Vertebrates species
- Freshwater resources
- Marine resources

Plant communities: Forest types at Kalaupapa include coastal strand vegetation communities, Loulu palm (*Pritchardia hillebrandii*) coastal forest, remnant lowland mesic forest, rare native vegetation on cliff faces, lowland rain forest, upper-elevation rain forests at Waikolu and Puu Alii, and diverse dry land native forest. The park supports 27 plant species listed as endangered, 2 threatened plant species, 5 candidates for endangered status, and at least 22 species of concern. Several endangered plant species have been reported from Kalaupapa Peninsula, and others may be on un-surveyed cliffs in or near the park. Awiwi (*Centaurium sebaeoides*), an endangered annual herb, and the threatened *Tetramolopium rockii* var. *rockii* are both strand community components. Offshore islets support unusual relict vegetation, as well as the endangered plant species *Scaevola coriacea* and *Brighamia rockii*. Many endangered species and species of concern are known from rain forests of Puu Alii NAR, some of which have not been observed for many years and are likely to be extinct. Carter's panicgrass (*Panicum fauriei* var. *carteri*) is found in the coastal spray zone. Endangered plants *Cyanea procera*and and *Melicope reflexa* are found in Waikolu Valley. A large number of endangered plants species and species of concern are known from Puu Alii Natural Area Reserve, Upper Waihanau Valley, and other areas near the park boundary.

Rare insect species: Candidate endangered damselfly species *Megalagrion pacificum* and *M. xanthomelas* are found in Waikolu Stream. These species are formerly widespread lowland species that have been extirpated from several islands. Three rare bee species are found at the nearby Moomomi Preserve and probably inhabit coastal areas of the park. The pond in Kauhako Crater contains unusual, possibly endemic, invertebrates.

Vertebrate species: A small population of endangered monk seals (*Monachus schauinslandi*) haul out on local beaches to give birth (i.e., “pup”), molt, or rest. Monk seals are almost entirely absent from the main Hawaiian Islands (MHI), and the population at Kalaupapa is one of the larger populations outside of the Northwestern Hawaiian Islands. The MHI population is estimated at around 60 individuals with Kalaupapa having approximately 20% of these (Baker and Johanos 2004). Threatened green sea turtles (*Chelonia mydas*) occur in the park where they forage and nest when beach conditions are suitable. Endangered humpback whales (*Megaptera novaeangliae*) transit through the park boundaries from December to May each year. Native birds, including kakawahie (*Paroreomyza flammea*), olomao (*Myadestes lanaiensis*), ou (*Psittirostra psittacea*), crested honeycreeper (*Palmeria dolei*), and the black mamo (*Drepanis funerea*), are all thought to be extinct, or in the case of the crested honeycreeper, extirpated, from Molokai and the park. Scott Wilson observed about the ou’s distribution in the islands, “I think that I found it most plentiful among the trees which clothe the abrupt sides of the deep ravine running down to the leper settlement on the island of Molokai” (Wilson and Evans 1890-1899). Iiwi (*Vestiaria coccinea*) is rarely seen on Molokai; however, it was sighted at Puu Alii in 2004 during the Hawaii Forest Bird Survey.

Freshwater resources: Lakes are extremely rare in Hawaii, and most are found at high elevations. Preliminary surveys of Lake Kauhako fauna have confirmed its unique characteristics including a new species of copepod. In 1999 a genetically isolated

population of shrimp was found there. Waikolu stream has been partially diverted for human use, but still provides habitat for all five native diadromous fish species, aquatic insects, shrimp, and a large population of the relatively uncommon native Hawaiian stream snail, hihiwai (*Neritina granosa*).

Marine resources: Marine resources found within 2,700 acres of shallow nearshore waters are numerous and include coral reefs, reef fish assemblages, algal and intertidal communities found on exposed basalt benches, low and high cliffs, basalt boulder and cobble beaches, black and carbonate sand beaches, and numerous tidepools. Marine biotic communities are well-adapted to the physical surroundings and oceanographic processes (including localized current patterns) that influence an exposed north-facing shoreline. Some marine species thought to be found only in the remote Northwestern Hawaiian Islands have been documented at Kalaupapa, such as the endemic limpet, *Cellana melanostoma* (Minton and Carnevale draft). Of particular importance to Kalaupapa is knowledge on the ecology of culturally important intertidal organisms (e.g., endemic species of opihi - *Cellana* sp.).

Threats & Stressors

Ranked in terms of management priorities, threats and stressors include;

- Feral animals
- Predatory invasive species
- Climate change
- Water diversion
- Pollutants
- Tsunami, hurricanes, and mass wasting

Feral animals: The vegetation of Kalaupapa is threatened by feral goats, pigs, and axis deer. The latter species appears to be the most damaging to the park's resources, especially in the dry forest. Pigs cause extensive damage on the Puu Alii plateau and in Waikolu valley. Detrimental effects include both plant community destruction through digging and herbivory, and subsequent erosion due to loose soil and impacted vegetation. Erosion reduces soil quality and affects stream resources, increasing sedimentation and affecting nutrient load. Pigs also facilitate the spread of disease by creating wallows where rain water can collect. Avian malaria (*Plasmodium*) is transmitted by mosquitoes (*Culex quinquefasciatus*) which lay larvae in these wallows. Leptospirosis can be contracted thru standing water in which rats, the hosts to the disease, have defecated.

Predatory invasive species: Rats consume native snails, plant seeds, and bird eggs. Mongooses consume bird eggs, chicks, and adults. Human impacts on offshore islets, even at low levels, may affect rare native plants, especially through introduction of alien species currently absent from the islets. Freshwater invertebrates are threatened by invasive species including predatory fish, ants, yellowjackets (*Vespula pensylvanica*),

snails, and the Tahitian prawn (*Macrobrachium lar*). Alien species (fish, mollusks, and crustaceans) could heavily impact native invertebrates in Lake Kauhako if introduced (as has been documented in Hawaiian anchialine pools) (Brock and Kam 1997). Introduced marine fish and invertebrates and potential invasion of alien algae may threaten native coral reef fauna and flora (Department of Land and Natural Resources 2003).

Climate change: Changes in climate may raise or lower the trade-wind inversion layer, changing precipitation patterns and thus affecting upland forest characteristics and stream flow. Ground-nesting birds, coral reefs, and monk seals may also be threatened by climate change due to rising sea levels and increasing severity of weather events, as well as increasing water temperatures.

Water diversion: Water diversion for agriculture and drinking water is a major stressor on stream habitat quality in Waikolu Stream, reducing base flow and increasing water temperature. This stressor has significant effects on stream and riparian organisms, which rely on intact native vegetation and streams with natural flow regimes and temperatures (Way et al. 1998).

Pollutants*:* Kalaupapa has two landfills, both of which are old and do not meet current EPA regulations. Neither is lined and both occur in the coastal zone. The older of the two dumps is near the ocean and is actively being eroded by the sea. Waves frequently remove solid waste from the dump and deposit it along the shoreline and in shallow subtidal areas. Little is known about the contents of these dumps which raises significant concerns that they may contain environmentally hazardous material. Household waste from residents and State of Hawaii and park staff on the Kalaupapa Peninsula goes into septic tanks. Circumstantial evidence in the intertidal zone suggests localized presence of high nutrients that may be associated with septic leaching. However, the park lacks conclusive data.

Tsunami, hurricanes, and mass wasting: Locally generated and teleseismic (from Alaska) tsunamis are potential threats to both biotic and geological resources. Hurricanes have the potential to cause extensive damage on the peninsula. Mass wasting occurs along the steep cliffs of Molokai 's north shore.

Water Quality Designations

Hawaii's surface and marine waters are classified according to their use by the Hawaii Department of Health under Hawaii Administrative Rules, Title 11, Ch. 54, 2000. The official Kalaupapa boundary extends one quarter mile offshore. Lake Kauhako is considered unique and the offshore coastal waters are considered pristine. There are no impaired waters on the peninsula. Inland waters are currently classified as 1A (in natural state as nearly as possible, with an absolute minimum of pollution from any human caused source). Marine waters are classified as AA (in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions). Marine bottom ecosystems are classified as I

(in their natural pristine state with an absolute minimum of pollution from any human-induced source).

CULTURAL ISSUES

- Destruction of archeological sites by alien vegetation and ungulates
- Hunting by community members
- Harvesting of aquatic resources

A large number of archeological sites are negatively impacted by encroaching vegetation. Trees and shrubs deform rock walls and graves. In addition, feral ungulates displace rock walls while making trails. Treatment of vegetation on all archeological sites is difficult due to the large area of the park and the extent of infestation of alien plants. Harvesting of both marine and stream resources is limited to residents but extraction from outside sources (poaching) may occur. Overall, fishing pressure is believed to be low, except for removal of endemic Hawaiian limpets (opihi). The park collected preliminary data that suggest opihi are heavily fished within the park. Resident and staff subsistence hunting on the peninsula creates support for the existence of feral ungulates and makes control efforts difficult.

MANAGEMENT ISSUES

Park Management

The Act authorizing Kalaupapa National Historical Park (Public Law 96-565 enacted December 22, 1980) set forth the following as the principal purposes of the park; to preserve and interpret the Kalaupapa settlement for the education and inspiration of present and future generations; to provide a well-maintained community in which the Kalaupapa Hansen's Disease patients are guaranteed that they may remain at Kalaupapa as long as they wish; to protect the current lifestyle of these patients and their individual privacy; to research, preserve, and maintain the present character of the community; to research, preserve, and maintain important historic structures, traditional Hawaiian sites, cultural values, and natural features; to provide for limited visitation by the general public; to provide that the preservation and interpretation of the settlement be managed and performed by patients and native Hawaiians to the extent practical, and that training opportunities be provided to such persons in management and interpretation of the settlement's cultural, historical, educational, and scenic resources. The park mandate also applies to managing natural resources. Park management documents (General Management Plan, Resource Management Plan, etc.) are available on-line at the NPS intranet site (http://www1.nrintra.nps.gov/im/units/pacn/parks/mgmt_docs.htm). This website is available only from NPS computer networks. Inquiries about public access should be directed to the park.

Degradation of native vegetation by feral ungulates requires specific management attention. Some fencing and ungulate removal has been done in certain areas in the Puu Alii plateau wet forest, as well as in remnant native areas on Kalaupapa Peninsula.

Following ungulate removal, restoration of native vegetation, weed control, monitoring of invertebrate pollinators and pests on outplanted seedlings, and stabilization of existing rare plant populations need to be addressed. Coastal *Pritchardia* forest and strand communities are currently being restored. Recommendations for plant species re-introduction or augmentation have been made for Kauhako Crater, which was recently fenced in preparation for a restoration effort.

Other issues include maintenance of water quality and aquatic species diversity in streams, restoration of vegetation in Lake Kauhako, and protection of nearshore marine waters including monk seal and sea turtle habitat. Keeping offshore islets free of invasive species is also critical due to the unique habitats and species present.

INVENTORIES

Existing Inventories in Park

Vegetation: Kepler and Kepler (1981) recorded 167 vascular plant species during the Hawaii forest bird survey. A botanical survey of Kauhako crater was completed by Linney in 1987. Medeiros et al. (1996) inventoried the crater plants, including ohe makai (*Reynoldsia sandwicensis*), a species of concern, as part of a resource and threat monitoring project. An inventory of Puu Alii was conducted as part of the 1988 NAR survey. Jacobi (1989) created vegetation maps of the upland plant communities of Molokai including Puu Alii NAR. Asherman et al. (1990) did a botanical reconnaissance of Kalaupapa and described both the native and exotic vegetation. Control of Java plum (*Syzygium cumini*) has been initiated by removing targeted trees and monitoring habitats to determine efficacy of eradication efforts. Plants of the north east coastal spray zone are detailed in Canfield (1990). Botanical inventories of the cliffs surrounding Kalaupapa are currently underway (as of September 2004). Legrande (2002) made some observations and a vascular plant checklist of Kukaiwaa Peninsula on the eastern boundary of the Park. Wood and Legrande (2002, 2003) made a checklist of the vascular plants on the three offshore islets of Huelo, Mokapu, and Okala documenting several important new plant records for the park. Wood and Hughes (2005, in prep.) conducted vascular plant surveys and made a checklist of Puu Alii Plateau, Upper Waihanau, Upper Waikolu, Upper Waileia, and the cliffs above Nihoa; this work continues in 2005 as a plant inventory project at the park. Wysong and Hughes (2005, in prep.) are developing an herbarium collection of all plant species occurring in the park. In summary, it is estimated that 90% of the terrestrial plant species within the park will be inventoried by 2006. Approximately 40% of the habitats have been mapped and are in the process of being updated.

Terrestrial Vertebrates: A forest bird survey in Puu Alii was last conducted in 2004. Resident and migratory seabirds were also surveyed in 2001 and 2003. An avian disease study was conducted at Kalaupapa and the surrounding Pelekunu Preserve, Kamakou Preserve, and Puu Alii Natural Area Reserve during 2003. The movement of axis deer was studied on the Kalaupapa Peninsula to better understand the life histories (Goltz et al. 2001)

Duvall (2000) inventoried reptiles on two of the offshore islets. A moth skink (*Lipinia noctua*) and mourning gecko (*Lepidodactylus lugubris*) were collected on Huelo Islet.

Terrestrial Invertebrates: In conjunction with a study on avian malaria, avian pox data was collected on the distribution and breeding habitats of the southern house mosquito.

Freshwater Community: The aquatic fauna of Lake Kauhako was surveyed in 1999 along with water quality and bacterial sampling. Several ecological studies have been conducted on macrofauna (fish, snails, and shrimp) in Waikolu and Pelekunu Streams (Brasher 1996, 1997a, 1997b). An inventory of the aquatic insect fauna of Waikolu stream was conducted in 1992 (Polhemus 1992). Other streams in the park have not been inventoried.

Marine Communities: Surveys of coral reef communities off Kalaupapa were conducted by the Army Corps of Engineers in the 1980s. Qualitative short-term surveys were done in 2001 for corals and fish by scientists from the Hawaii Coral Reef Assessment and Monitoring Program (CRAMP). A cursory inventory of marine vegetation was conducted by Alan Friedlander and Eric Brown in 2004. It is estimated that the most common algae have been documented, which represents ~10% of the total number of species. A more in-depth study is planned with the University of Hawaii Botany Department through a cooperative agreement with NPS. Marine vertebrates have not been systematically inventoried, although approximately 80% of the fish species have been documented by Alan Friedlander and Eric Brown in 2004 using quantitative surveys of fish assemblages. Jim Beets, Alan Friedlander, and Eric Brown are scheduled to complete the marine vertebrate inventory in 2005 through an NPS grant. Kalaupapa, along with Pacific Island Coral Reef Program (PICRP), developed a database for marine fish species inventories. Marine invertebrate fauna have been surveyed by Minton and Carnevale (draft) and supplemented by Scott Godwin of Bishop Museum in 2005 (E. Brown, pers. com.). It is estimated that <33% of the invertebrate fauna has been inventoried, with an emphasis on the intertidal community. Some preliminary work has been done subtidally on macroinvertebrates by Minton and Carnevale (draft) and Eric Brown and Alan Friedlander in 2004. It is estimated, however, that ~10% of the total number of subtidal benthic species have been observed. Corals and other benthic biota were surveyed once in 2004 (E. Brown and A. Friedlander, pers. com.) with the intention of initiating a monitoring program in 2005.

Geology: The Natural Resources Conservation Service (NRCS) has soil maps for all Hawaiian islands based on research conducted in the 1950s and 1960s (Cline et al. 1955, Foote et al. 1972). The focus of existing soil survey mapping was on agricultural land use and was generalized for other areas. Soil studies in or near Kalaupapa occurred in 1951 and 1963 (Carlson 1951, Fernandez 1963). A study concerning the impacts of sand mining on dunes in the park was completed in 1988 (Canfield 1988). Other surveys of the area include an inventory of the hydrology network for Molokai in 1970 (Hawaii Division of Water And Land Development 1970), groundwater studies in 1983, 1991, and 1992 (Kauahikaua 1983, M & E Pacific, Incorporated 1991, Mink and Lau 1992, Oki

1992), surface water studies in 1985, 1986, 1990 and 1995 (Takasaki 1985, Takasaki 1986, Smith 1990, Anthony 1995, Diaz et. al. 1995), and park specific studies (Takasaki 1982, National Park Service 1996). Many of these reports focus on the Waikolu and Waihanau valleys. The Waikolu stream is the source of a transbasin water diversion system, operating since 1961, which sends water to western Molokai. Kalaupapa is a member of the recently formed East Molokai Watershed Partnership. This coalition is composed of a group of landowners, government agencies, and non-government organizations whose purpose is to cooperate in the management of natural ecosystems to preserve native ecosystems and conserve watersheds. A project was identified in Kalaupapa's Resource Management Plan to compare hydrologic and biologic attributes of the Waikolu Stream watershed with hydrologic and biologic attributes of the nearby Pelekunu Stream watershed. Studies have shown that the Waikolu diversions have caused adverse effects on instream biotic resources while Pelekunu Stream has remained in a more natural state (Brasher 1997b).

Water quality: A baseline water quality data inventory and analysis was conducted by the National Park Service, Water Resources Division. Limited information from a drinking water supply well indicates no significant changes in this resource since its construction in 1987. The EPA updated the 2002 Hawaii coastal Environmental Monitoring and Assessment Program (EMAP) sample design to include open coastal areas as well as embayments in the 2004 assessment. Preliminary site selection maps indicate a sampling location very near to Kalaupapa's eastern boundary. The water column in a unique saline lake in Kahakau Crater, has been studied for salinity and temperature profiles with depth.

Landscape: Some preliminary sound testing was conducted at Kalaupapa in May 2003 by the Natural Sound Program. This information will be primarily used to assess the natural soundscape for the upcoming Air Tour Management Plan. Visitor statistics are tracked by the Park Service and are available at http://www2.nature.nps.gov/stats/.

Priorities for New Inventories in Park

Vegetation: Vegetation mapping at a scale that shows native vegetation fragments and patch size is needed, especially for Waikolu Valley.

Terrestrial Vertebrates: Complete herpetological inventories for Kalaupapa are lacking.

Terrestrial Invertebrates: Invertebrate surveys are needed for all areas of native vegetation, especially coastal strand and wet forest sites that may have rare species and/or high diversity.

Freshwater Communities: Inventories of intermittent streams on the peninsula are lacking. Biotic baseline inventories of macrofauna and invertebrates in all streams in the park are needed. Lake Kauhako should be inventoried, with an emphasis on unique invertebrates.

Marine Communities: A continuation of the marine benthic surveys is necessary to enhance the existing inventory. In addition, plankton surveys should be conducted to document surface and mid-water organisms. Marine benthic habitats are poorly delineated with no benthic habitat maps and ~10% classified using point estimates from fish surveys (Friedlander and Brown).

Buffer Zone Inventories

Terrestrial Vertebrates: Forest bird surveys have been conducted at Kamakou preserve and Molokai Forest reserve.

Marine Communities: Hawaiian monk seal inventories are being conducted on the leeward shores of Molokai Island. Preliminary surveys on marine fish assemblages have been conducted along the eastern buffer zone to Haupu bay by Friedlander and Brown in 2004. At present no subtidal marine work has been done outside the western boundary.

MONITORING

Existing Monitoring in Park

Marine Communities: Culturally important intertidal marine invertebrates (e.g. opihi) have been monitored by Chris Bird (UH-botany) since 2003. This study is ongoing with plans to continue the monitoring effort through the Kalaupapa marine program. A program to assess spatial and temporal patterns of coral recruitment and to provide baseline data on the identity of coral recruits began in 2004. A coral reef monitoring program is being initiated that will focus on coral abundance (percent cover), density of other subtidal macroinvertebrates, algal abundance (percent cover), and fish assemblage characteristics (species richness, abundance, biomass, and diversity). Utilizing similar protocols to collect standardized metrics (e.g., percent cover) will enable comparisons at a larger spatial scale. Monitoring of resident monk seal beach and shoreline use is currently occurring in the park.

Water Quality*:* The USGS measured temperature, pH, and discharge of headwaters and streams that pass through Kalaupapa. Two stations on Waikolu Stream (gages #16408000 and #16405500) were monitored from 1969 to 1976 and one in the Molokai Tunnel east portal (gage #16405100) was monitored from 1975 to 1989. Two other stream gages in the park were operated between 1940 and 1944 on Waihanau Stream (gage #16409000) and Keolewa Stream (gage #16410000).

Air Quality/Climate: Air quality and fire danger monitoring on the Kalaupapa peninsula occurs as part of the Remote Automated Weather Station (RAWS) monitoring network. Temperature, relative humidity, wind speed and gusts, wind direction, total solar radiation, fuel moisture, and soil moisture are measured.

Priorities for New Monitoring in Park

Vegetation: The top priority for future monitoring is vegetation community recovery after ungulate removal. Potential monitoring programs have been designed and implemented for the threatened *Tetramolopium rockii* var. *rockii* and the endangered *Centaurium sebaeoides*. Currently about 30 rare plants and 34 non-rare species (including dominant and keystone species) are being propagated for out-planting. Monitoring the success of out-planting includes mapping and tracking planted vegetation, observing insect pests and pollinator populations, long-term monitoring of known rare plants, especially in Kauhako Crater, and following ungulate populations.

Vertebrates: Forest bird populations on the peninsula and in the valleys as well as breeding populations on off shore islets need to be monitored. Medeiros et al. (1996) recommended studies to determine the impacts of rodents on rare tree species at Kauhako Crater. Ungulate removal sites from a section of Puu Alii plateau and Waikolu Valley need to be more effectively monitored to evaluate the effects of animal removal on native habitat and native species.

Freshwater Communities**:** Monitoring needs include aquatic fauna, especially hihiwai populations in Waikolu and other streams. The streams have multiple stressors. More detailed monitoring of the Kauhako Crater lake fauna would provide vital information on possible endemic species.

Marine Communities: Marine fish assemblages need to be monitored both inside and outside of the park. This program is also a top priority as fishing pressures increases from outside sources. Currently no monitoring programs have been initiated to track changes in population structure of the threatened green sea turtle and the endangered humpback whale. Targeted key marine invertebrate species (e.g. lobster-*Panuliris sp.* and Octopus, *Octopus sp.*) should be monitored. A coral reef monitoring program is planned for 2005. The sampling design will adhere to the statewide Coral Reef Assessment and Monitoring Program (CRAMP 2001) protocol to allow for larger spatial comparisons.

Water Quality**.** No water quality monitoring is conducted in the park at this time. The framework for a cooperative monitoring system on an island-wide level is in place through work with the federal Enterprise Community (EC) designation and implementation, and United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Watershed Restoration Action Strategy for the south shore of Molokai.

Buffer Zone Monitoring

Vegetation: The Nature Conservancy of Hawaii conducts semiannual vegetation monitoring in Pelekunu and Kamakou Preserves

Vertebrate: The Nature Conservancy of Hawaii conducts biannual ungulate surveys in Kamakou and Pelekunu preserves. Ungulate transects are monitored in Puu Alii Natural Area Reserve by the State of Hawaii Department of Land and Natural Resources. US Fish and Wildlife forest bird surveys were recently conducted in Kamakou Preserve, Pelekunu Preserve, Puu Alii NAR, and Molokai Forest Reserve.

Invertebrate: Monitoring of invertebrates in relation to the plant A*stelia menziesiana* is conducted by USGS-BRD in Kamakou Preserve.

Native Freshwater Communities: Monitoring of fresh water biota was conducted in Pelekunu stream and detailed in a Brasher (1997a and 1997b).

Marine: The Reef Program has two sites near the park, site 4304 on the north side of Molokai (Ilio Pt-Halava) and site 43040001 on the north shore cliffs (Wailau Valley) (See www.reef.org). Monitoring of fish assemblages in buffer zones is planned in 2005 to allow for comparisons with fish populations inside the park boundaries. As part of the coral reef monitoring program, several sites will be established outside of the park for comparative purposes. The focus will be on trends in coral cover over time. In addition, no buffer zone monitoring of intertidal opihi is taking place so surveys outside of the park will need to be initiated to evaluate population trends within the park

Water quality: USGS has stream gauges measuring flow, temperature, and pH near the diversion tunnels of headwater streams.

Geology: The most complete historical, empirical data on location of earthquake epicenters with attributes information for date, depth, and magnitude is be available from the USGS National Earthquake Information Center (NEIC). The operational objective of the Tsunami Warning System (TWS) in the Pacific is to detect and locate major earthquakes in the Pacific region, to determine whether they have generated tsunami. This allows for timely and effective tsunami information and warnings to the population of the Pacific to minimize the hazards of tsunami, especially to human life and welfare. To achieve this objective, the TWS continuously monitors the seismic activity and ocean surface level of the Pacific Basin. A study of potential tsunami inundation zones for Molokai was completed in 1968 (Adams 1968).

Weather: RAWS stations are located in the adjacent Natural Area Reserve. A National Weather (NWS) station is also located nearby.

CONCLUSIONS

While the original intention of Kalaupapa National Historical Park was to ensure the protection of unique cultural resources, the park contains significant natural resources. These include coastal cliffs, offshore islets, coral reefs, marine resources, seal hauling beaches, dryland forest, a unique lake, perennial and intermittent streams, and mid-elevation rain forest. The official inclusion of the marine waters within the park is rare in the Hawaii parks and adds important resources to the park jurisdiction. These resources are threatened by natural and anthropogenic factors including invasive species such as exotic plants, insects, alien algae, fish, feral ungulates, as well as by water diversion, climate change, and natural hazards. Measures such as vegetation restoration, fencing, removing ungulates, exotic plant management, and protecting marine resources are key to preserving the unique and diverse natural resources that Kalaupapa encompasses.

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